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SOLUTION.

The equation of the normal referred to the centre and asymptotes is

$$y - y' = \frac{x'}{y'}(x - x').$$

The half product of the values of x when $y = 0$, and y when $x = 0$, gives for the area of the triangle $(x'^2 - y'^2)/(2x'y')$. [H. W. Draughon.]

189

SHOW how to resolve a given force into three coplanar components acting in given lines not concurrent.

SOLUTION.

Let F be the force, a *point vector*. Since the lines are coplanar and non-current, they form a triangle. Let its vertices be e_1, e_2, e_3 , and hence the three lines, e_1e_2, e_2e_3, e_3e_1 . Then, if x_1, x_2, x_3 are scalar constants, we have

$$F = x_1e_2e_3 + x_2e_3e_1 + x_3e_1e_2.$$

Multiplying by e_1 , $e_1F = x_1e_1e_2e_3$, or $x_1 = \frac{e_1F}{e_1e_2e_3}$;

and similarly $x_2 = \frac{e_2F}{e_1e_2e_3}, x_3 = \frac{e_3F}{e_1e_2e_3}$.

Hence $F = \frac{1}{e_1e_2e_3}(e_1F \cdot e_2e_3 + e_2F \cdot e_3e_1 + e_3F \cdot e_1e_2)$.

Thus the length of the component on e_1e_2 is the length of e_1e_2 times the ratio of the triangle formed by joining e_3 with the ends of F to the triangle $e_1e_2e_3$; and similarly for other components. [E. W. Hyde.]

EXERCISES.

213

FIND the centre of gravity of the area of one quadrant of the tetracuspid $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$. [R. H. Graves.]

214

An equilateral hyperbola is circumscribed to a triangle. Find the greatest and least values of the transverse axis. [R. H. Graves.]

215

Two equal circles, radii r , intersect; find the average area common to both. [Artemas Martin.]

216

Two equal spheres, radii r , intersect; find the average volume common to both. [Artemas Martin.]

217

A CIRCLE is drawn at random within a given circle. What is the probability that the random circle contains the centre of the given circle? [Artemas Martin.]

218

THE lengths of none of three lines exceeds a ; find the probability that an acute triangle can be formed with them. [Artemas Martin.]

YALE PRIZE PROBLEMS.

SENIOR.

219

IMAGINE a homogeneous elastic string for which the law of elasticity is such that the length of any portion varies as the tension to which it is subjected. A loop of such a string is in equilibrium under the action of a central force, which repels the material of the string inversely as the square of the distance from the centre. What form (other than a circle) may the loop have?

220

A and B are two fixed points 4 units apart. AC and BD are two bars, each 5 units long, pivoted at C and D to the extremities of a third bar 2 units long. What is the deviation from a straight line in the curve described by the middle point of CD while AC and BD cross each other.

221

DISCUSS the remarkable points connected with the spherical triangle, such as the orthocentre, incentre, circumcentre, etc.

222

GIVE the formula for a table of meridional parts for a constant negative curvature ($r = 5$). [If we wish to make a plane map of the surface in which angles shall be preserved, an arbitrarily chosen geodetic line of the surface may be represented in the map by a straight line and on a uniform scale, like the equator in Mercator's chart. Lines equidistant from the geodetic in the surface will be represented by parallel lines in the map, and the formula required is one which will give the distances from the fundamental line at which these parallels are to be drawn.]

223

THE points P, Q, R, S are taken on the faces of the tetrahedron $ABCD$, viz. P on the face BCD , etc. The ratios of the triangles PBC, PCD, PDB to the whole face BCD are given, and the corresponding ratios for the other faces. Required the ratio of the tetrahedra $PQRS$ and $ABCD$.

224

A CYLINDER whose radius is r , lying lengthwise in a rough horizontal cylindrical trough of radius R , receives a slight impact at right angles to its axis; discuss the resulting motion.

225

AN ellipse whose axes are $2a$ and $2b$, and whose centre is fixed at A , rolls upon a horizontal plane situated at the distance c below A . Discuss the curve which the ellipse traces upon the plane.

JUNIOR.

226

IF the angles of a triangle as computed from slightly erroneous measurements of the sides, are A, B , and C , the errors in the sides being α, β , and γ ; prove that the consequent errors in the cotangents of the angles are proportional to

$$\frac{\beta \cos C + \gamma \cos B - \alpha}{\sin A}, \quad \frac{\gamma \cos A + \alpha \cos C - \beta}{\sin B}, \quad \frac{\alpha \cos B + \beta \cos A - \gamma}{\sin C}.$$

227

WRITE a rule for the extraction of the cube root in duodecimals, and as an example, find to five places the diameter of a sphere which contains one cubic foot.

228

SUPPOSE a vessel in the form of an inverted frustum of a cone to be filled with water, and then tipped until as much water runs out as is possible without uncovering any part of the bottom; required, the volume of the water which remains.